1749

C-574
TEST EQUIPMENT DESIGN
MISSILE
NOV 7 1960

Operating Instructions

for

1749

F.M. DEVIATION METER

Type TF 928/2

SUPPLIED AND SERVICED BY:
MARCONI
INSTRUMENTS
111 CEDAR LANE
ENGLEWOOD N. J.

Marconi Instruments Limited
ST. ALBANS · HERTFORDSHIRE · ENGLAND

MARCONI INSTRUMENTS

EB 928/2
1 - 10/57

OPERATING INSTRUCTIONS No. EB 928/2

for

F.M. DEVIATION METER TYPE TF 928/2

Supplement for inclusion before Page 1
of Operating Instructions No. EB 928/1

The F.M. Deviation Meter Type TF 928/2 differs from the TF 928/1 described in the accompanying Operating Instructions in that

(1) The carrier frequency range is now 215 to 265 Mc/s.

(2) The minimum input level is now 20 mV and the maximum is 2 volts.

In all other respects, the TF 928/2 is identical to the TF 928/1 described in the accompanying instructions.

DRAWINGS (supplied instead of those listed on Page 2 under "CONTENTS")

BLOCK SCHEMATIC DIAGRAM.....TBB 23459
CIRCUIT DIAGRAM.....TD 26735/1

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EB 928/1
1 - 8/57

OPERATING INSTRUCTIONS No. EB 928/1

for

F.M. DEVIATION METER TYPE TF 928/1

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DRAWINGS

BLOCK SCHEMATIC DIAGRAM..... TBB 23459
CIRCUIT DIAGRAM..... TD 26735

SCHEDULE OF PARTS SUPPLIED

The complete equipment comprises the following items:-

One F.M. Deviation Meter Type TF 928/1 complete with valves, etc., as under:-

Valves:	Seven:	Type CV138 (6AM6) Pentodes.
	Three:	Type CV140 (6AL5) Double Diodes.
	Two:	Type CV133 (6C4) Triodes.
	One:	Type CV284 (QS75/20) Voltage Stabilizer.
	One:	Type CV286 (QS95/10) Voltage Stabilizer.
	One:	Type CV378 (12E1) Tetrode.
	One:	Type CV345 (53KU) Full-Wave Rectifier.
	One:	Type CV2127 (6CH6) Pentode.
	One:	Type CV850 (6AK5) Pentode.
Crystals:	One:	M.W.T. Type 1655D, 500-kc/s Oscillator Crystal.
	One:	Type CV2290 (GEX66) Germanium Diode.
Lamps:	Two:	6.5-volt, 0.3-amp, M.E.S. Pilot Lamps.
Fuses:	Five:	3-amp Glass Cartridge Fuses.

(One of the lamps and three of the fuses listed above are spares stowed on the interior of the case lid.)

2. One Mains Lead Type 103A (ZD 01914); 3-core; 5-ft long.

3. One Coaxial Connector, Type TM 4969; 3-ft long, 50-ohm, BNC plug both ends.

4. One Coaxial Adaptor, Type TM 4971; 6-inches long; one end, BNC socket; other end, crocodile clips.

5. One Instruction Book No. EB 928/1.

M.I. Ltd.

1. DESCRIPTION

1.1. GENERAL

The Marconi Deviation Meter Type TF 928/1 measures deviations up to 150 kc/s at carrier frequencies between 215 and 235 Mc/s. It has three direct-reading deviation ranges of 15, 50, and 150 kc/s full-scale and includes a built-in crystal-controlled deviation standard which allows the accuracy of deviation indication to be checked and adjusted by the user.

The modulation frequency range is 50 c/s to 100 kc/s, and the input signal can be at any level between the nominal limits 5 mV and 0.5 volt. In addition to operating the directly calibrated deviation meter, the demodulated f.m. signal is fed to front-panel outlets to permit aural or visual external monitoring.

The TF 928/1 is a rugged military-style instrument and can be operated from any 40- to 100-c/s a.c. supply within the voltage ranges 100 to 150 volts and 200 to 250 volts.

1.2. DESIGN DETAILS

1.2.1. Measuring Circuit

The input is fed via a buffer amplifier to a frequency changer comprising a tunable local oscillator and a germanium diode mixer. The difference-frequency signal is amplified by wide-band i.f. stages and converted to a square wave by a limiter circuit. Demodulation is effected by a rectifying and differentiating circuit which, from the square wave, develops undirectional pulses. These pulses are integrated by a low-pass filter which produces a voltage varying in proportion to the frequency of the square wave; the amplitude of the alternating component of the filter output waveform is, therefore, a measure of the deviation, and its frequency is that of the original modulation. This facsimile of the l.f. signal originally applied to frequency modulate the carrier is amplified and then fed to a diode-rectifier voltmeter having meter scales calibrated directly in deviation.

1.2.1. (Continued)

The deviation corresponding to full-scale on the meter is determined by the setting of the deviation-range switch, each different setting giving a different sensitivity for the demodulator.

1.2.2. Standardizing and Checking Facilities

On the front panel is a six-position selector switch. Three positions provide facilities for setting up the instrument and checking the input signal, before the remaining positions - DEVIATION RANGE kc/s - are employed for making a deviation measurement.

At the first switch position - SET DEVIATION - the output from the first i.f. stage is disconnected, and the second i.f. stage is converted to a crystal oscillator operating at 500 kc/s. At the same time, a potential at the supply frequency is applied to the screen grid of the following i.f. valve so that the signal from the 500-kc/s oscillator is alternately suppressed and amplified. This produces a test signal of constant effective deviation against which the meter deviation scale may be standardized by adjustment of a preset panel control that determines the gain of the l.f. amplifier.

With the switch at its second position - TUNE - the connection from the first i.f. stage is restored and the d.c. component of the pulses derived from the i.f. signal is indicated on the panel meter. The meter deflection then serves as a measure of the mean i.f., enabling the local oscillator to be tuned so that the correct mean i.f. is obtained before making a deviation measurement.

To check that there is sufficient input for correct limiting, the selector is set to the third position - CHECK INPUT. The meter then shows the level of input to the limiter.

1.2.3. L.F. Output

As well as being rectified and displayed on the indicating meter, the output from the cathode follower terminating the l.f. amplifier is passed to outlets on the front panel; this provision

1.2.3. (Continued)

permits aural and visual external monitoring of the demodulated signal.

1.2.4. Power Supply

The internal power unit of the Deviation Meter includes a mains transformer, full-wave rectifier, and a series-regulator type h.t. stabilizing circuit. The primary connections of the transformer can be adjusted so that the instrument is suitable for operation from 40- to 100-c/s a.c. supplies in the ranges 100 to 150 volts and 200 to 250 volts.

2. OPERATION

2.1. INSTALLATION

Unless otherwise specified, the instrument is normally despatched with its valves and crystal in their holders and with the mains transformer adjusted for operation from a 240-volt, 40- to 100-c/s supply. For other voltages between 200 and 250 volts, open the window on the front panel and adjust the tappings accordingly. For voltages between 100 and 150 volts, unscrew the tapping plugs and reverse the tapping plate and switch setting; then screw in the tapping plugs as required.

2.2. SWITCHING ON

Before switching on, be sure that the instrument is correctly adjusted to suit the particular mains supply to which it is to be connected. Then proceed as follows:-

(1) Connect the mains lead - which is stowed, when not in use, inside the lid of the case - between the front-panel mains input plug and the supply socket.

(2) Switch ON by means of the supply ON/OFF switch, and note that the red pilot lamp glows.

(3) Before proceeding further, allow a short time - say, five minutes - to elapse for the internal circuits to warm up.

2.3. SETTING UP DEVIATION METER AND MAKING A MEASUREMENT

2.3.1. Standardizing Deviation Scale

Turn the selector switch to SET DEVIATION. The meter should deflect to the SET DEVIATION mark; if not, uncover the SET DEVIATION preset control and adjust it until the correct reading is obtained.

2.3.1. (Continued)

This check is not necessary before every measurement but should be made periodically.

When the instrument is operated from a supply having a frequency other than 50 c/s, a slightly different meter setting is required and this is discussed in Section 2.5.

2.3.2. Applying Signal to be Measured

The two coaxial sockets on the front panel are both type BNC and mate with 50-ohm BNC plugs (United States, Military No. UG-88/U; Great Britain, Transradio Ltd. type BN.1/5). A coaxial connector, Type TM 4969, is supplied with the instrument for connecting either inlet to the source under test. Also supplied is a coaxial adaptor, Type TM 4971, (BNC socket to crocodile clips) which can be plugged onto the coaxial connector if a temporary clip connection to the equipment under test is desired.

The input impedance at the HIGH LEVEL inlet is 52 ohms; at the LOW LEVEL inlet, the impedance is somewhat higher and is normally about 80 ohms.

The range of input levels acceptable is 5 mV to 50 mV at the LOW LEVEL inlet and 50 mV to 500 mV at the HIGH LEVEL inlet.

When it is known that a signal will develop less than the maximum rated 500 mV but its exact value is uncertain, the HIGH LEVEL inlet should be employed initially; if, in the level test which follows tuning, the signal is found to be too weak, it can be applied instead to the LOW LEVEL inlet.

2.3.3. Tuning, Checking Input Level, and Reading Deviation

(1) Turn the selector switch to TUNE and set the tuning dial to the frequency of the source. Then slowly tune through the signal.

2.3.3. (Continued)

It will be found that two maxima are indicated by the meter, one above and one below the carrier frequency. Between these two maxima there is a central point of minimum response at which the local oscillator of the Deviation Meter coincides in frequency with the carrier of the source under test.

Working from this central point of minimum response, slowly shift the tuning point of the Deviation Meter towards one or other of the adjacent maxima and continue until the meter reads at the TUNE mark.

NOTE: Do not continue tuning beyond a peak and set up on the sloping response on the far side; it is essential that the setting-up should be done on the side adjacent to the central point of minimum response.

(2) Turn the selector switch to CHECK INPUT and note that the meter deflects to above the MIN INPUT mark.

If it fails to do so, transfer the signal to the LOW LEVEL inlet and/or increase the signal level until a reading above the MIN INPUT mark is obtained; then repeat operation (1) so that the meter again reads at the TUNE mark.

When the input is adequate, variation of the level of the incoming signal should not change the meter indication when it has been set to TUNE as in (1).

(3) Set the selector switch to DEVIATION RANGE 150 kc/s or, when the order of deviation is already known, to the appropriate range. Reset the selector switch, if necessary, to the most sensitive range on which the deflection does not exceed full-scale. Read the deviation, multiplying the meter-scale indication by the factor engraved at the selector switch setting.

2.4. ASYMMETRIC MODULATION AND CARRIER SHIFT

The deviation indicated by the meter is the result of rectification of the l.f. products of demodulation. Thus, the indication is derived from the peak value of one polarity of the l.f. waveform - corresponding to the peak deviation in one direction. When the local oscillator is tuned above the signal frequency, the indication is derived from the positive deviation (i.e., deviation towards a higher frequency); when it is tuned below the signal frequency, the indication is derived from the negative deviation. If different deviation readings are obtained after setting to TUNE, first above and then below the central point of minimum response, this is an indication that the input is asymmetrically modulated.

Significant changes in the effective carrier frequency due to modulation can be detected by first tuning the Deviation Meter to the unmodulated signal and then, with the selector switch still at TUNE, applying the modulation. If the meter indication alters to above or below the TUNE mark on the application of modulation, this is an indication of carrier shift.

2.5. SETTING UP AT SUPPLY FREQUENCIES OTHER THAN 50 c/s

If the Deviation Meter is operated from a supply having a frequency other than 50 c/s, the deflection that should be obtained when the selector switch is turned to SET DEVIATION as in Section 2.3.1 is above or below the SET DEVIATION mark in accordance with the following table. The SET DEVIATION preset control must be adjusted accordingly.

TABLE 1

Supply Frequency	With selector switch at SET DEVIATION, meter should indicate:-
50 c/s	SET DEVIATION, i.e., 25.75
60 c/s	25.5
100 c/s	24.7
40 c/s	26.3

2.5. (Continued)

Alternatively, if it is expected that the instrument will be permanently operated at a supply frequency other than 50 c/s, the user may find it preferable to reset the deviation reading as described in Section 3.6.2 employing the new supply frequency. It will then be correct to set up the instrument to read exactly at the SET DEVIATION mark; the above table will then no longer be valid.

2.6. USE OF L.F. OUTLETS

The output of the l.f. amplifier is available at a pair of terminals and a jack socket connected in parallel with them. This enables the modulating waveform of the input signal to be checked visually or aurally on an oscilloscope, distortion factor meter, wave analyser, headphones or other monitoring apparatus.

The output impedance is of the order of 600 ohms, and the open-circuit level is approximately 1 volt when the meter is indicating full-scale on any of the deviation ranges.

The l.f. response of the instrument is substantially level up to 100 kc/s; no de-emphasis arrangements are included.

3. MAINTENANCE

3.1. GENERAL

Before commencing the adjustment or replacement of any component part of the instrument, the user should familiarize himself with the principles dealt with in Section 1, DESCRIPTION, and illustrated in the Block Schematic Diagram.

The complete Circuit Diagram, at the end of this section, shows all the electrical components of the instrument and lists their values, ratings etc.

3.2. REPLACEMENT OF FUSES

The circuits of the TF 928/1 are protected by a 3-amp fuse in each mains input line and both are accessible from the front panel. Three spare fuses are stowed on the inside of the case lid.

3.3. REMOVAL OF CASE

The instrument is attached to its case by means of the four 1/4" BSF screws in each of the front-panel flanges. Removal and replacement can be carried out with the instrument standing normally on its base but, where convenient, it is preferable to stand it face upwards.

On re-assembly, make sure that the two locating spigots inside the rear of the case are correctly engaged in their corresponding holes at the rear of the chassis.

3.4. WORKING VOLTAGES

The following voltages were obtained from measurements on a representative TF 928/1; the voltmeter employed was an AvoMeter Model 8 which has a resistance of 20 kΩ per volt.

3.4. (Continued)

The Selector switch was set to TUNE.

Before measuring these voltages, be sure the mains transformer tapping plugs are set in accordance with the supply voltage.

H.T. and Filament Supplies

Voltage	Measured between:-	Reading
H.T. a.c.	HT-CT-HT tags on TR1	385-0-385 V a.c.
H.T. rectified	V16 pin 8 and chassis	410 V d.c.
H.T. stabilized	V17 pin 8 and chassis	230 V d.c.
Series valve screen supply	V17 pin 4 and chassis	350 V d.c.
Control valve anode supply	V18 pin 5 and chassis	215 V d.c.
Reference voltage	V19 pins 5, 6, 7 and chassis	95 V d.c.
Filament supply a-b	LT1 tags on TR1	6.3 V a.c.
Filament supply c-d	LT2 tags on TR1	6.3 V a.c.
Rectifier filament supply	LT3 tags on TR1	5.0 V a.c.

3.4. (Continued)

Electrode Voltages

See Circuit Diagram for electrode pin numbers.

Valve	Anode V d.c.	Screen V d.c.	Cathode V d.c.
V1	144	144	2.05
V2	155*	-	-
V4	120	125	1.05
V5	138	165	1.6
V6	168	175	1.95
V7	205	230	1.8
V8	148	230	7.3
V10	70	-	0
V12	160	57	0.4
V13	170	58	0.38
V14	230	-	37

* Measured at h.t. end of anode feed resistor, R11.

3.5. REPLACEMENT OF VALVES

All valves may be replaced without special selection although, in certain cases, replacement may necessitate some readjustment to associated preset controls. For example, replacing the local-oscillator valve, V2, may alter the capacitance across the tuned circuit and affect the calibration accuracy of the tuning dial; the dial calibration should, therefore, be checked after replacement of this valve. Similarly, in the case of any other valve,

3.5. (Continued)

the user should carefully consider the possible effect on the performance of the stage or stages involved; the following table lists the valves whose replacement is more likely to necessitate some readjustment and indicates the appropriate realignment procedure.

Valve No.	Check or readjust:-	Section describing readjustment
V2	Tuning dial calibration	3.6.4
V4 to V8	Deviation indication	3.6.2
V10	Deviation indication	3.6.2
V12 to V14	Deviation indication	3.6.2
V16 to V19	Stabilized h.t. voltage	3.6.1

3.6. ADJUSTMENT OF PRESET CONTROLS

3.6.1. H.T. Voltage

After replacement of valves or other components in the Power Unit, check that the stabilized h.t. voltage , as measured between the cathode (pin 8) of V17 and chassis, is 230 volts d.c. If not, make adjustment by means of preset potentiometer RV2, which is accessible from the underside of the chassis.

3.6.2. Deviation Reading

With a signal of known deviation applied to the instrument, the indication is adjusted by means of the SET DEVIATION control, RV1, which determines the gain of the l.f. amplifier between the integrating filter and the meter. This control affects all three ranges; the indication on individual ranges can be adjusted by means of trimmer capacitors C37, C40, and C43, which determine the time constants of their associated R-C networks. When the deviation has been corrected on all three ranges, the meter is standardized in the SET DEVIATION condition by adjusting RV3, a preset potentiometer brought into series with the meter when the instrument is switched to SET DEVIATION.

This procedure, which is detailed below, should be carried out after changing any component affecting the overall sensitivity of the instrument or the performance of the 500-kc/s standard-deviation signal.

(1) Apply a signal with a known deviation of less than 15 kc/s - preferably determined by the Bessel zero or "disappearing carrier" method - to one of the INPUT plugs.

(2) With the Selector switch at TUNE, bring the meter pointer to the TUNE mark in the normal manner.

(3) Turn the Selector switch to DEVIATION RANGE 15 kc/s and adjust the SET DEVIATION preset control, RV1, so that the meter correctly indicates the known deviation referred to in (1) above. If the setting of RV1 is within, say, 45° of either end of its travel, set it mid-way and adjust preset capacitor C43 for a correct indication.

(4) Switch to DEVIATION RANGE 50 kc/s, increase the deviation to a suitable known value, and check the accuracy of indication. Make adjustment, if necessary, by means of preset capacitor C40.

3.6.2. (Continued)

(5) Switch to DEVIATION RANGE 150 kc/s and correct any inaccuracy in meter reading by means of preset capacitor C37.

(6) Turn the Selector switch to SET DEVIATION and adjust preset potentiometer RV3 to bring the meter indication to the SET DEVIATION mark.

3.6.3. Sensitivity

Over the greater part of the tuning range, the sensitivity of the instrument should be such that, with the selector switch in the CHECK INPUT position, a signal level of 5 mV at the LOW LEVEL inlet is sufficient to cause the meter to deflect to above the MIN INPUT mark. If the sensitivity drops appreciably from this towards one end of the other of the r.f. range, adjust preset capacitor C5 to equalize the response. During factory calibration, C5 is adjusted in conjunction with the windings of L3 and L5 of the r.f. amplifier output transformer to give optimum frequency response over the r.f. range; it will be appreciated that the degree of coupling from the local oscillator to the mixer is also dependent upon the setting of this capacitor and the user is recommended not to make any adjustment to it unless it is strictly necessary.

If the sensitivity is uniformly low throughout the band, the fault may be localized by checking the d.c. output current of mixer MR1; the value is largely dependent upon the local oscillator output and should be about 30-μA. The r.f. amplifier and mixer have approximately unity stage gain, with the result that the i.f. sensitivity is of the same order as the r.f. sensitivity.

3.6.4. Tuning Dial Calibration

Turn the Selector switch to TUNE and connect a signal generator to one of the input plugs.

3.6.4. (Continued)

Adjust the frequency of the unmodulated generator output in steps to the calibration frequencies of the TF 928/1. At each frequency, tune the TF 928/1 to the central minimum in its response, as indicated by the meter, and check that the error in dial reading does not exceed 2%; if it does, readjust trimmer capacitor C5 for optimum accuracy throughout the range.

It should be possible to tune the local oscillator at least 1 Mc/s beyond the nominal limits at each end of the band.

BLOCK SCHEMATIC
OF
F.M. DEVIATION METER
TYPE TF 928 -/1

MARCONI INSTRUMENTS LIMITED

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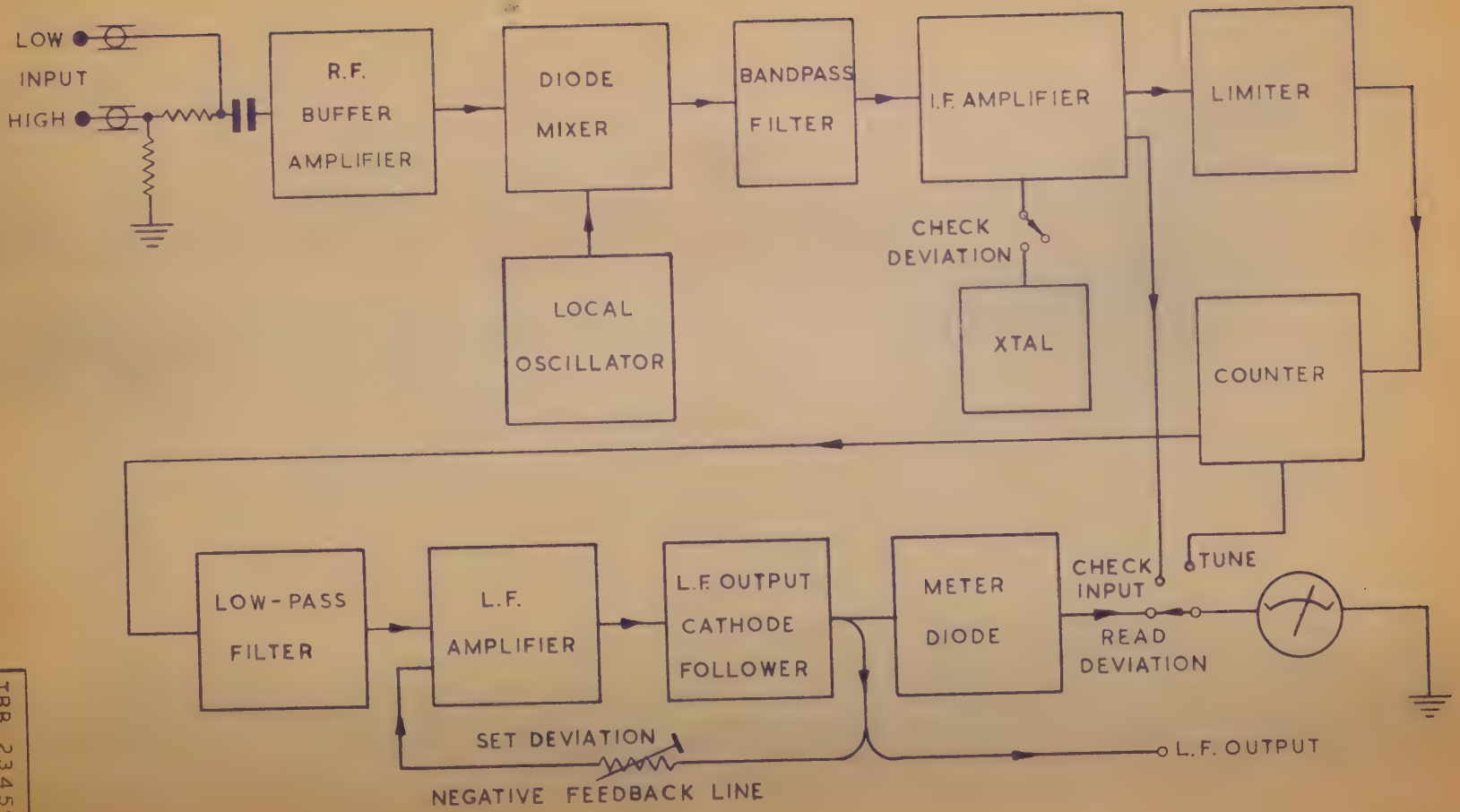
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